Globelics

Technology and development: Unpacking the relationship(s)

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Abstract

Innovation is, as Joseph Schumpeter once pointed out, above all a combinatory phenomenon. Success in accessing knowledge and exploiting it in a way that is beneficial for development depends on the ability to combine many different skills and resources, of which many will be external to the firm. Arguably, political choices, past as well as present, the quality of governance and the business environment, availability of skills, finance and broader social and cultural characteristics may all have a say for how well this combinatory dynamics works. Based on a review of the literature on how technological, economic and social factors interact in the development process this paper sets out to explore these interrelationships empirically. The results, based on data for 75 countries on different levels of development, suggest that there is a strong correlation between technological capability, (innovation-friendly) governance and social capital, confirming, it is suggested, the important role played by politics and deeper social and cultural factors for technological catch-up (or lack of such). This contrasts with the role played by for instance openness to trade, FDI, etc., which - according to the results presented here - hardly correlates with anything.

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1. Introduction

The idea that technology plays an important role in development has been around for a long time. Nearly a century ago Torstein Veblen used evidence from the German industrialization process to argue that technological catch up by industrial latecomers was indeed possible, and that several other countries such as for example Japan would be likely to exploit this opportunity (Veblen 1915). After the Second World War this optimistic scenario was taken over by the neoclassical strand in economics, which gradually came to dominate the discipline (Solow 1956, 1970). According to this way of thinking, technology should be seen as a freely available "public good", facilitating development everywhere as long as markets are allowed to "do their job" properly.

However, from the 1960s onwards the view, put forward by among others the economic historians Alexander Gerschenkron and Moses Abramovitz (Gerschenkron 1962, Abramovitz 1979, 1986), that differences in development were mainly caused by technological differences and that technological catch-up by late-comers was far from easy, received increasing support. This view of technology received further backing from a series of empirical studies of industrialization processes in Asia and Latin-America (Kim 1980, Fransman 1982, Fransman and King 1984, Dalhlman et al. 1987, Lall 1987). At the macro level this led to the formulation of the so-called "technology gap theory of economic growth" (Fagerberg 1987, 1988, Verspagen 1991). The focus on technology as the driving force of growth and development has been taken up by advocates of the so-called "new growth theory" (Lucas 1988, Romer 1990, Aghion and Howitt 1992).

A commonly held view in this literature is that firms and countries that do not succeed in developing appropriate technological activities will continue to lag behind. Concepts such as "technological capability" (Kim 1980), "technological mastery" (Dahlman and Westphal (1982), "technological capacity" (Bell 1984), "innovative activity" (Fagerberg 1987), "innovation capability" (Dahlman et al. 1987), "absorptive capacity" (Cohen and Levintal 1990), "innovation system" (Lundvall 1992, Nelson 1993, Edquist 1997) and "innovative capacity" (Furman et al. 2002) have been suggested as interpretative frameworks for analyses of this aspect of development. Other writers have chosen to broaden the perspective to include

a wider set of social and economic variables. Abramovitz (1986), building on earlier work by Ohkawa and Rosovsky (1974), used the term "social capability" as a shorthand for such factors, including among other things education, governance and honesty and trust. In a similar vein the term "social capital" has been invoked by writers who emphasize the role of social and cultural factors for development (Putnam 1993, Woolcock and Narayan 2000).

In this paper we wish to explore further the interrelationships between various technological, economic and social factors in development. Based on a review of the existing literature in this area, we identify several different dimensions of these capabilities (Section 2). Taking advantage of the fact that many new indicators on non-economic aspects of development have become available recently, in Section 3 we develop with the help of factor-analysis empirical measures of these dimensions and analyse their interrelationships. Section 4 concludes with a discussion of the implications of these findings for policy.

2. Taking stock of the literature

Intuitively, most people would easily accept the idea that technology and economic development are intimately related. However, economic theorists have faced great problems in incorporating technology into their analysis. As mentioned above this had to do with a particular view on technology that had come to dominate economics; namely as a body of information, freely available to all interested, that can be used without being depleted over and over again. Arguably, if this is what technology is about, it should be expected to benefit everybody all over the globe to the same extent, and cannot be invoked to explain differences in development.

It is understandable, therefore, that the first systematic attempts to conceptualise the relationship between technology and development did not come from the economics mainstream. It was the economic historian Alexander Gerschenkron who came to set the stage for much of the subsequent literature (Gerschenkron 1962). He argued, based on historical analyses of European catch-up with the then leading nation (the UK), that although the technological gap between a frontier country and a laggard represents "a great promise" for the latter - a potential for high growth through imitating frontier technologies - there are also problems that may prevent backward countries from reaping the potential benefits to the full extent. His favourite example was the German attempt to catch up with Britain more than a

century ago. When Britain industrialized, technology was relatively labour intensive and small scale. But in the course of time technology became much more capital and scale intensive, so when Germany entered the scene, the conditions for entry had changed considerably. Because of this, Gerschenkron argued, Germany had to develop new institutional instruments for overcoming these obstacles, above all in the financial sector, "instruments for which there was little or no counterpart in an established industrial country" (ibid, p. 7). He held these experiences to be valid also for other technologically lagging countries.

Social capability

Moses Abramovitz, arguing along similar lines as Gerschenkron, also placed emphasis on the potential for catch-up by late-comers which he defined as follows: "This is a potential that reflects these countries' greater opportunity to advance by borrowing and adapting the best practice technology and organization of more productive economies" (Abramovitz, 1994a, p. 87). He suggested that differences in countries' abilities to exploit this potential might to some extent be explained by differences in so-called "social capability". What Abramovitz had in mind was not only individual skills (acquired through education) but "collective capabilities" related to what organizations in the private and public sector are capable of doing and how this is supported (or hampered) by broader social and cultural factors (as exemplified by the spread of honesty and trust across the population).

Arguably, the approaches of Gerschenkron and Abramovitz were rooted in a specific view of modernity that developed as a result of the rise of the US economy to global economic leadership during the previous century. This perspective, whose most prominent advocate came to be the US business-historian Alfred Chandler (1962, 1977), focused on the economics of large, integrated companies and the social, economic and organizational capabilities needed to support and finance them. Hence, it was assumed that countries seeking to catch up with the frontier would have to place emphasis on emulating these capabilities (Chandler 1990). Innovation, although acknowledged as important, was, implicitly at least, assumed to depend on these capabilities and did not get a whole lot of attention.

The concept "social capability" has become very popular in applied work but there have not been many attempts to develop empirical measures reflecting the factors that Abramovitz

alluded to. In fact he pointed out himself in later work that the concept remained "vaguely" defined (Abramovitz 1994b, p. 24) and expressed pessimism with respect to the possibilities for adequate measurement. In practical applications it has often been assumed to be synonymous with educational attainment (Baumol et al. 1989), which is arguably an important element, but a much more narrow perspective than what Abramovitz had in mind.

Technological capability

The study of the catch-up of Japan but also a host of other so-called "newly industrializing countries" (NICs) in the 1970s and 1980s led to an increased emphasis on the role of technological activities (or capabilities). Although much of this literature focused on the firm and industry levels and specific countries (Kim 1980, 1987, Fransman 1982, Fransman and King 1984, Dalhlman et al. 1987, Lall 1987, 1992, for an overview see Romijn 1999), other studies extended the analysis to include the dynamics of the global economy (Fagerberg 1987, 1988, Dosi, Pavitt and Soete 1990, see Fagerberg and Godinho 2004 for further details). One case which received much attention was the rise of Korea from being one of the poorest countries in the world to first world technological powerhouse in just three decades (Amsden 1989, Kim and Dahlman 1992, Kim 1980, 1997).

Kim (1980) suggested the concept "technological capability", which he in later work defined as "the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies"[1] (Kim 1997, p. 4), as a tool for the analysis of the Korean case. As has become common in the literature (Dalhlman et al. 1987), Kim considered three aspects of it: production capability, investment capability and innovation capability. Thus, the concept includes not only organized R&D, which arguably is a small activity in many developing countries. This broader perspective is, as we shall explain in more detail later, essential when discussing the role of innovation (and innovation policy) in the developing part of the world. Kim (1997) and other writers also emphasized that the requirements became more stringent, in particular with respect to innovation capabilities, as countries climbed up the development ladder. Hence, for a catching-up country, the appropriate level of technological capability (Lall 1992) will be a moving target.

National innovation system

The 1990s also saw the birth of a large body of research aimed at exploring the interrelationships between firm level exploration and exploitation of knowledge and external knowledge providers, many of them public, and the important role of policy and governance in shaping this dynamics. The concept "national innovation system", first used in public by Christoper Freeman in an analysis of the Japan (Freeman 1987), became a popular analytical tool for researchers who wanted to get a firmer grasp of what determined such interaction (Lundvall 1992, Nelson 1993 and Edquist 1997). Organizations such as the OECD, the EU and the UN intensified their efforts to provide relevant statistics with which performance along these lines could be assessed. However, the adoption of the innovation system approach to developing countries is a relatively recent phenomenon and arguably still in its infancy (Viotti 2002, Muchie et al. 2003, Lundvall et al. 2006).

Moreover, there is currently no agreement in the literature on how innovation systems should be defined and studied empirically.[2] Edquist (2004, p. 182) argues for example that national systems of innovation include "all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations". Trying to put numbers on such broad concepts may be a difficult exercise, as Archibugi and Coco (2005) point out. Still there have been some attempts in that direction. For instance, Furman et al. (2002) and Furman and Hayes (2004) have suggested to measure a country's innovation system (or its "innovative capacity" as they put it) through the number of patents and find that there are large differences in this respect across countries at similar levels of income. This, to us, appears to be a too narrow approach. First, patents refer to inventions, not innovations, and are used much more intensively in some industries than others. Second, the global novelty requirement associated with patents implies that minor innovations/adaptations, which arguably make up the bulk of innovative activity world-wide, will not be counted since these are simply not patentable. Thus, for countries below the technology frontier, and developing countries in particular, most of their innovative activities would get unrecognized by this approach. Arguably, a broader perspective is needed.

New growth theory

Neoclassical economists' interest in the possible role of technology for growth and development also increased during the 1980s and 1990s. An important development was the emergence of the so-called "new growth theory" (Romer 1986, 1990; Aghion and Howitt, 1992, 1998) according to which differences in economic development across countries should be understood as the outcome of differences in endogenous knowledge accumulation within (largely national) borders. Although some newly created technological knowledge may spill over from one country to another, there are according to this approach sufficient impediments to this process (being legal, such as intellectual property rights (IPRs), or more informal in nature) to secure that in most cases the lion's share of the benefits will accrue to the innovator. Hence, following this approach long run economic growth should to a large extent be expected to depend on appropriability conditions and the enforcement of intellectual property rights. The increasing attention to IPRs in both developed and developing countries and their mutual relationship (for example the TRIPS agreement, see Granstrand 2004) may to some extent reflect this shift of emphasis in economic theorizing.

Social capital

More than four decades ago Irma Adelman and Cynthia Morris (1965) concluded, on the basis of an in-depth study of a number of indicators on development for a large number of countries, that "the purely economic performance of a community is strongly conditioned by the social and political setting in which economic activity takes place" (p. 578). Adelman and Morris saw economic development as contingent on broader social and political changes accompanying the transition from a traditional (rural) ways of life, based on high degree of self-sufficiency, to a modern industrialized society characterized by market-relationships and new forms of institutions and governance. Although, this important insight largely got lost in the years that followed, during the nineties interests in the social (societal) prerequisites for economic development and catching-up rebounded.

In an important contribution, aimed at explaining the marked gap in economic development between two Italian regions, Robert Putnam (1993) put forward the argument that this gap had to do with different capacities for responding to social and economic challenges through appropriate forms of collective action. Such differences did according to Putnam reflect historically given social norms, networking and civic engagements, or "social capital" as he put it, using an already established sociological term.[3] This contributed to a rapidly increasing

body of research on the role of social capital in development. Michael Woolcock and Deepa Narayan of the World Bank, in a survey, define social capital as "norms and networks that enable people to act collectively" (Woolcock and Narayan 2000). A central theme in the policy relevant literature on the subject has thus become what governments can do to support the creation of trust and strengthen constructive collaboration across different (social, political, religious, ethnic etc.) groups.

The fact that the type of factors taken up by the literature on social capital may matter for economic development is widely accepted. For instance, Kenneth Arrow pointed out more than three decades ago that "It can plausibly be argued that much of the economic backwardness in the world can be explained by lack of mutual confidence" (Arrow 1972, p. 357). The importance of honesty and trust was, as mentioned previously, also emphasized by Abramovitz (1994). The problem is rather how to measure and influence such factors. One possible source of information that has been exploited to throw some light on the issue is the "World Value Survey". Stephen Knack and Philip Keefer used such data to analyze the relationship between trust, norms of civic behavior and membership in groups on the one hand and economic growth on the other for a sample of 29 (mostly developed) countries (Knack and Keefer 1997). They found trust and civic behavior (but not group membership) to be positively related to investment and economic growth. These results are suggestive but the limited country coverage of these data has until recently precluded its extension to the developing part of the world.

An alternative way to approach the interrelationship between economic, social and political forces in development, based on the pioneering work by Adelman and Morris (1965), has been suggested by Jonathan Temple and Paul Johnson (Temple 1998, Temple and Johnson 1998). It was shown that the variation in a wide set of indicators on different aspects of development could be reduced, with the help of factor analysis, to four common factors, one of which was deemed especially significant. This factor, an amalgam of structural indicators (share of agriculture, urbanization etc.), socio-economic characteristics (role of middle class, social mobility, literacy etc.) and the development of mass communication (measured through the spread of newspapers and radios in the population), is what Temple and Johnson suggest using as a measure of "social capability" which, they argue, embraces "social capital".[4] They demonstrate that the resulting measure has considerable explanatory power for growth performance. However, it clearly is a mixed bag of different types of variables, of which some

have little to do with "social" factors. Arguably, we still lack a satisfactory measure of "social capability" and/or "social capital" that covers a broad range of countries.

Structural factors

The emphasis on structural factors that is characteristic for the Adelman-Morris and Temple-Johnson approach is, of course, not new. The view that development requires extensive structural changes, substituting low productivity agriculture and natural resource based industry with high productivity manufacturing industries, has been around for a long time (Kaldor 1967). According to this view, development should be seen as a transformation process through which the industrial composition changes and overall productivity increase along the route (Chenery et al. 1986). Measures of development based on this perspective naturally focus on productivity at the level of the sector/industry and the industrial composition of GDP.

An example of such a measure is the "competitive industrial performance index" (CIP) used by UNIDO (2002) which is a mixture of productivity in manufacturing, export orientation and shares of medium- and high-tech activities in manufacturing value added and exports, respectively. It follows that export-oriented countries with a high emphasis on manufacturing, particularly so-called high and medium technology products, will tend to score high on the index. A possible weak point is the dependence on a relatively arbitrary division of commodities into high, medium and low technology (Lall 2000). Such classifications, although widely used, tend to mask important differences within individual commodity groups. For example, the same group (within ICTs for instance) may include both cheap, standardized, mass produced products and top of the range, high-end, customized equipment sold at high prices to the most demanding segments of the market. Since trade statistics measures turnover or sales (not value added), the ranking of countries by specialization in high-tech exports may become highly biased upwards by their involvement in low value added, low skill segments of global production networks, such as assembling of electronics from imported components (Srholec 2007).

Another type of "structural" indicators focuses on the relationship between a country's production or trade structure and the changing composition of global demand. The argument, advanced by among others Thirlwall (1979) and Kaldor (1981), is that it is more conducive to

the economic growth of a country if it is specialized in products that are in high demand in international markets (and hence have a high income elasticity of demand). A more direct measure for the same, suggested by Fagerberg, et al. (2007), would be to weigh the growth of world demand with the commodity composition of a country's exports. However, although it is difficult to deny that such differences may have an impact, it is also important to emphasize the historically specific character of such relationships. Over the long run the distribution of growth rates over products is bound to undergo important changes, and so will the benefits (or lack of such) associated with any given pattern of specialization. Thus, what matters most in a longer perspective may be the ability to adapt to such changes (Fagerberg and Sollie 1987, Fagerberg and Srholec 2004).

Successful catch-up and rapid structural change are no doubt closely related (Fagerberg 1996). But what is cause and what is effect? Attempts to explain the superior productivity growth of catching-up economies compared to other countries as resulting from reallocation of resources from low productivity to high productivity industries have at best explained a small part of the actual difference (Fagerberg 2000). Hence, it seems more likely that rapid structural change and successful catch up are both outcomes of more generic factors of the type discussed in the previous section (and which we are also going to discuss in the following).

3. Stylized facts on economic, technological and social aspects of development

To explore the interrelationships between economic, technological and social aspects of development we have collected data from various sources for 75 countries, the majority of which are low or medium income. Since the time series for many relevant indicators are short, we focus on recent evidence. In an attempt to increase coverage across countries and limit influence of shocks and measurement errors occurring in specific years most indicators are measured as five-year averages over 2000-2004. In spite of this there were some missing data that had to be estimated (see appendix for details on definitions, sources and the estimation procedure).

A common approach in the literature is to use theory to determine which indicators refer to a specific dimension and then combine these indicators typically using equal weights. An alternative way to tackle this issue is, as previously mentioned, to assume that indicators that are strongly correlated refer to the same dimension of reality. Based on this assumption factor analysis can be used to identify these "latent" dimensions and hence also the weights needed to combine the various indicators. However, since in cross-sectional data sets most aspects of development tend to be highly correlated, there is a danger that this approach may not reveal much more than just that. Therefore we chose to use a combination of these two approaches. First, we consult theory to identify the dimensions and, in each case, the relevant indicators and then use factor analysis to weigh them together.[5] The advantage of this procedure - in contrast to many previous attempts in the literature (see Archibugi and Coco 2005 and references therein) - is that it allows us to test the extent to which a set of indicators allegedly reflecting the same dimension of reality are in fact strongly correlated. In our view this increases the confidence in the results.

As shown in the previous section, some analysts of national innovation systems favour a very broad approach, including everything that might "influence the development, diffusion, and use of innovations" (Edquist 2004, p. 182). However, such a holistic approach should not necessarily lead to attempts to develop a single measure covering almost everything. Rather, what we need to do is to identify measureable aspects of this complex reality and analyse how these aspects interrelate. The most basic distinction that we will apply here is between technological and social capabilities. Technological capabilities we define, in the spirit of Kim (1997), as the ability to search for, create and use knowledge commercially. It thus includes not only the ability to create "new to the world inventions" (Furman, et al. 2002) but also minor improvements and adaptations to local conditions (that may not be equally glamorous but matter a lot economically). Therefore it covers not only "innovation" capabilities but also abilities related to organization, production, and commercialization, e.g., what Kim and others had in mind with their emphasis on the "production" and "investment" aspects of "technological capability".

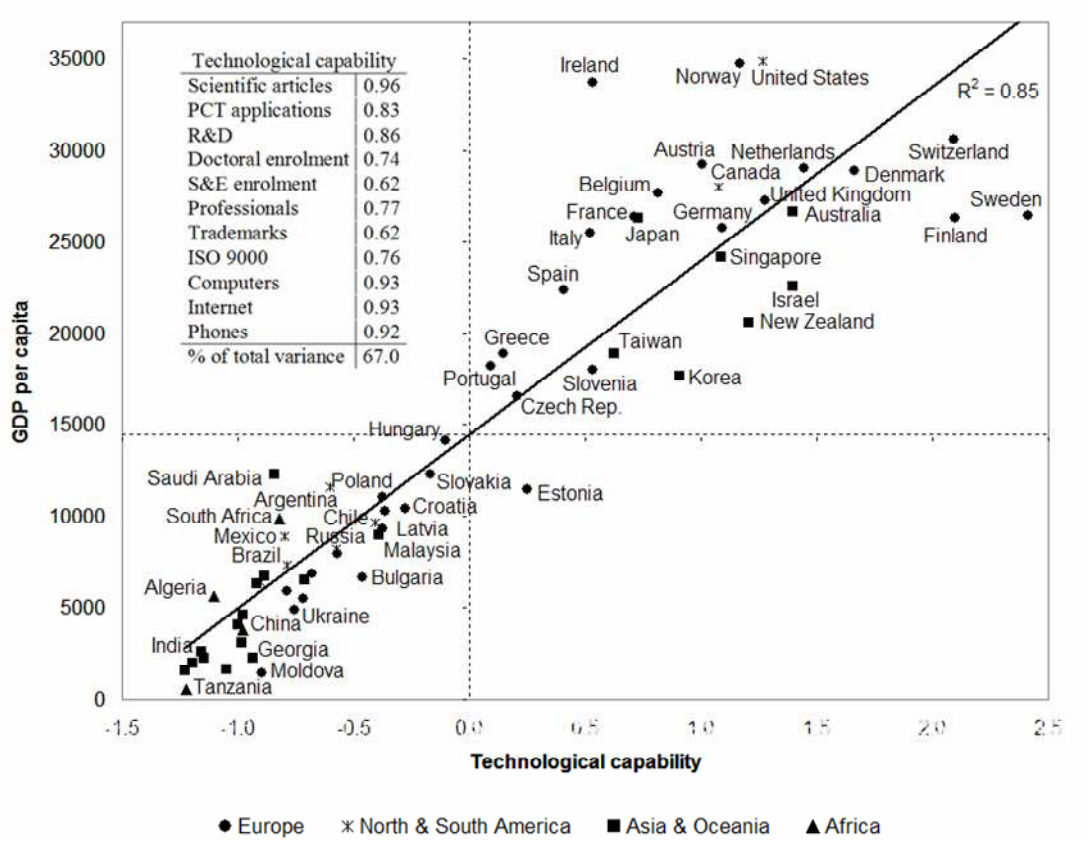
Such capabilities to a large extent reside in firms but extend beyond that to networks of various public and private organizations (of the type analysed by Nelson 1993) with which firms regularly interact in the exploitation of knowledge. Social capabilities, in contrast, are characteristics of the social context that firms, organisations and individuals share. Such

broader contextual variables do of course in many cases influence firm's actions, including their ability to develop and profit from technological capabilities, but they also have a certain degree of autonomy which is why we prefer to identify and measure them separately.

Figure 1 outlines the indicators taken into account to measure technological capability and provides results of the factor analysis. As emphasized by Nelson (2004), because of the increasing complexity of modern technologies, advanced research and training becomes a prerequisite for the ability not only to develop, but also to understand and assimilate technology. The quality of a country's research base is represented by publications in scientific journals, international patent applications (PCT) and R&D expenditure, while advanced training is captured by enrolment in doctoral programmes, science and engineering (S&E) education and the share of professionals and technicians in employment. However, as pointed out above, it is not enough to be aware of technological opportunities, these also need to be exploited in practice, and that requires competences in production, marketing, etc. Adherence to quality standards (ISO) may be a good indicator in this respect. Another available indicator arguably reflecting "close to the market" innovative activities, e.g., competences of a type that would normally get unrecognized by patents or R&D statistics, is the number of registered trademarks. Arguably, access to state of the art ICT is also very important for firms' ability to exploit knowledge commercially and we therefore include three indicators reflecting different aspects of the ICT infrastructure.

As is shown by the results from the factor analysis, reported in the upper left quadrant of Figure 1, all indicators taken into account are strongly correlated with the capability measure, which accounts for 67% of the total variance of these eleven indicators. [6] The figure also plots our measure of technological capability against GDP per capita (in PPPs) for the countries in our sample. Two observations follow more or less immediately. First the very close correlation between the two: about 85% of the variation in GDP per capita is "explained" by technological capability, which arguably is a "must" for developing countries that wish to catch up with the developed ones.[7] The second observation is the skew distribution. At the top we find the developed world enlarged by Israel and the successful new entrants from Asia (Korea, Taiwan, Singapore), in the middle there are a few former socialist countries in Europe, while most of the developing countries (with rather low values on both) cluster at the very bottom.

Figure 1. GDP per capita and technological capability over 2000-2004



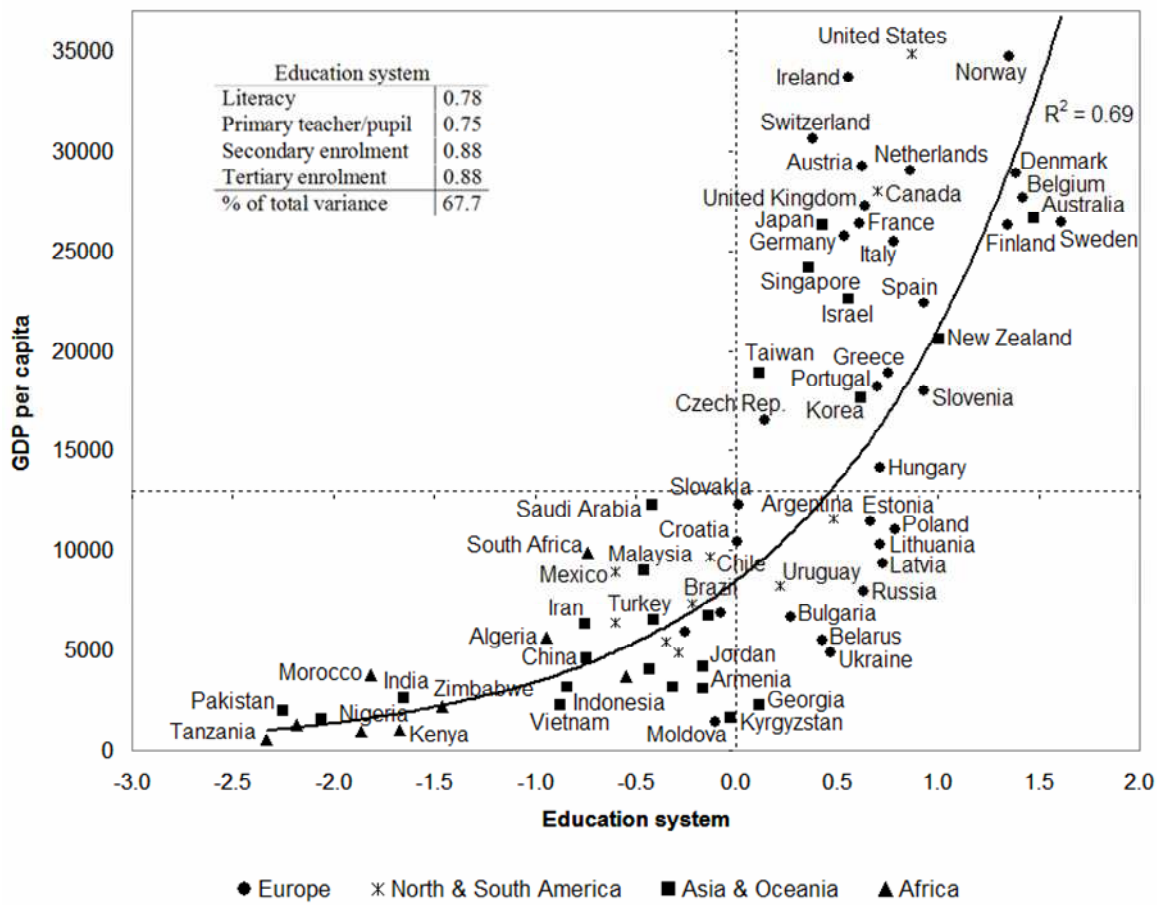
The overall picture that emerges from Figure 1 is consistent with the results reported by Archibugi and Coco (2004), but reveals a somewhat different pattern than what followed from the more narrow (patent-based) approach pursued by Furman, et al. (2002). While their calculations point to the US, Switzerland, Japan, Germany and Sweden as technological leaders, the front-runners in our case are all small countries (Sweden, Switzerland, Finland, Denmark and the Netherlands). This finding is suggestive. It well might be that the success of the latter countries, which are among the richest in the world, has to do with particularly well developed abilities in exploiting knowledge, rather than the capability to "invent" in a narrow sense.

Although much of the information used above, such as statistics on patents, trademarks, standards etc., reflects activities in firms, it would of course have been preferable to be able to supplement this with a more direct measure of innovative activity at the firm level. From the early 1990s European countries started to carry out so-called Community Innovation Surveys (CIS) of innovation activities in firms (see Smith, 2004 and OECD, 2005 for details), and more recently other countries, including some developing, have started to collect the same type of information (UNU-INTECH, 2004). Another recent survey, the Productivity and

Investment Climate Survey (PICS) by the World Bank, also includes information on innovation activities in firms in developing countries (see World Bank, 2003 for details). The results of these surveys are broadly consistent with the argument made here that innovative activity is not confined to a small number of highly developed countries but is important in the developing world as well. Unfortunately, the number of countries conducting such surveys is still much too low to allow inclusion in the factor analysis presented above. Furthermore, the questions posed about innovation in the CIS and PICS are not directly comparable, and each of these surveys also suffers from other limitations that make broad cross-country comparisons problematic.[8] There is no doubt, however, that such surveys provide valuable insights about innovation activities in developing countries, and will be an important source of information for research in the years to come.

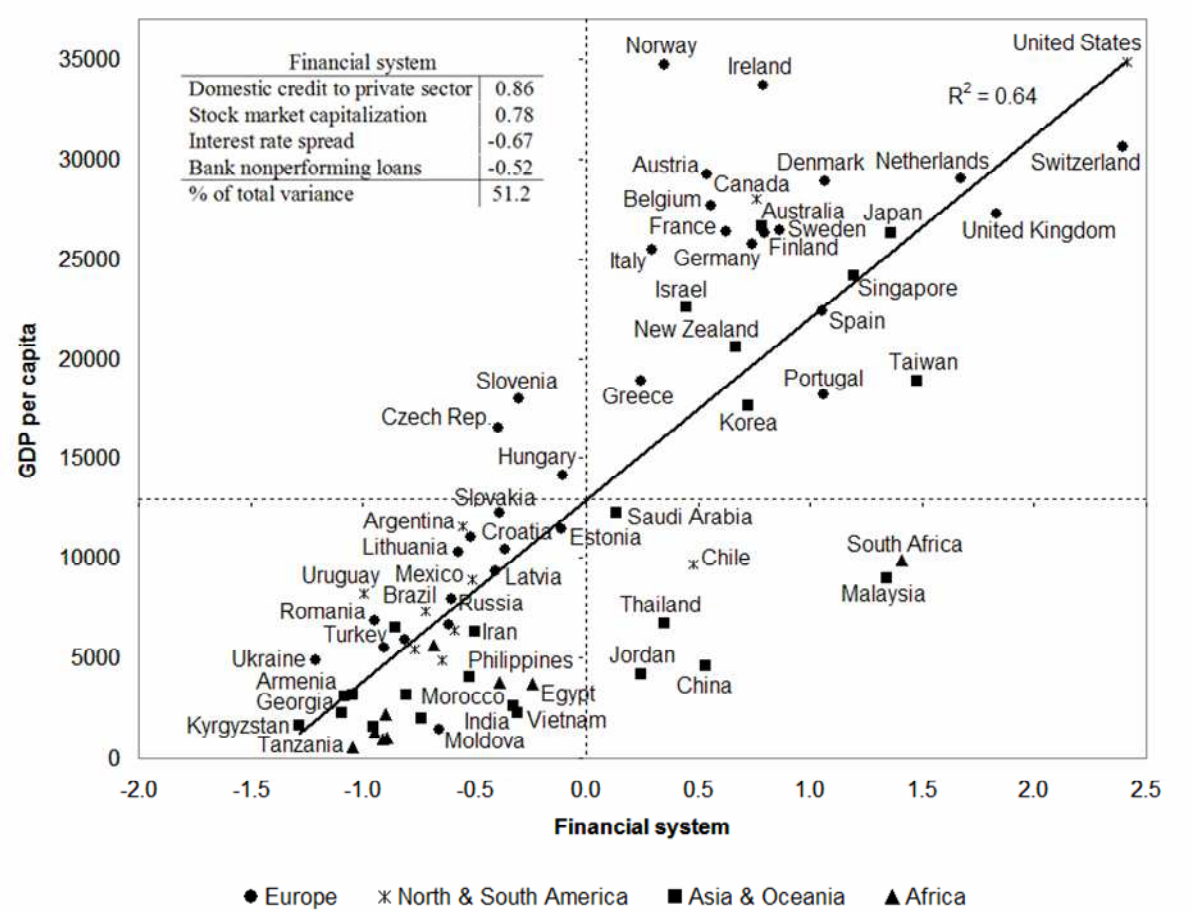
Figures 2-5 illustrate the various "social capabilities" that, according to Abramovitz and others, are necessary for the successful technological catch up to occur. The first measures the quality of the "education system" of a country by the degree of literacy of the adult population, the teacher-pupil ratio in primary education and gross enrolments in secondary and tertiary programmes. The second factor of social capabilities, "financial system" reflects the degree of development and efficiency of financial institutions in a country. Third, "business regulation" refers to the "innovation-friendliness" of governance and bureaucracy. It reflects how easy it is to set up (or close) a business, protection of IPRs, if laws and order are adhered to and to what extent corruption is a problem. Finally "social capital" – or perhaps better "social cohesion" – is a measure of the openness of society to people with different characteristics (origin, gender, sexual orientation etc.), the degree of trust among the citizens of a nation and the willingness to participate in civic activities (such as signing a petition). As pointed out in the previous section, it is generally acknowledged that culturally embedded characteristics of this type may matter for development, but a comprehensive measure has been lacking. As previously the results of the factor analysis are reproduced in the upper (lower) corner of the figures.

Figure 2. GDP per capita and education system over 2000-2004



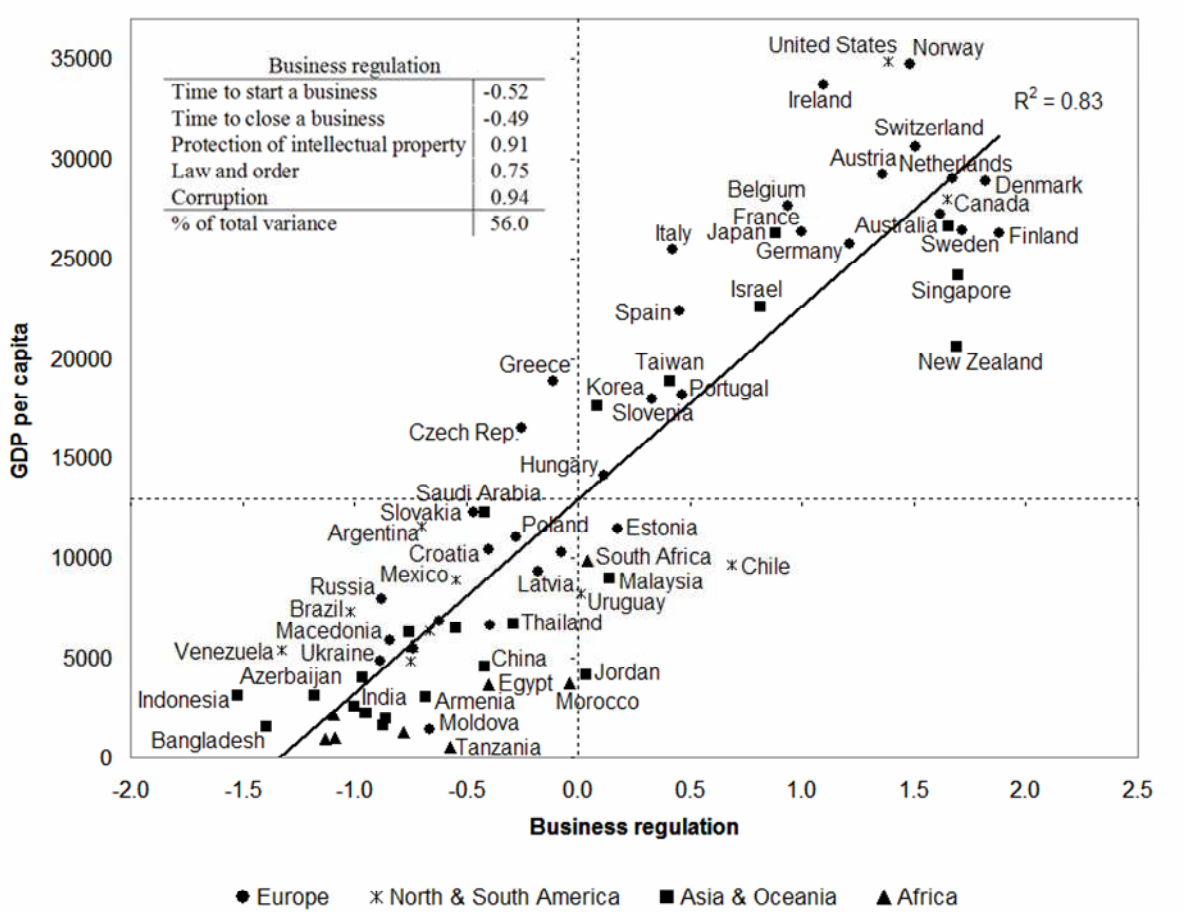
Space does not allow us to comment extensively on these statistics so we will limit it to a few observations. First, all of these "social capabilities" correlate positively with development as reflected by GDP per capita. The correlation is particularly strong with "business regulation", emphasizing the crucial role of "innovation friendly" governance in development (Figure 4). Second, for "education system" the relationship with GDP per capita is clearly non-linear (Figure 2). For the poorest countries, the regression line has a very low slope (almost horizontal), indicating large variations in education for countries at comparable levels of GDP per capita. Hence, although investment in education may well be a necessary condition for escaping the low-development trap it is clearly not a sufficient one.[9]

Figure 3. GDP per capita and financial system over 2000-2004



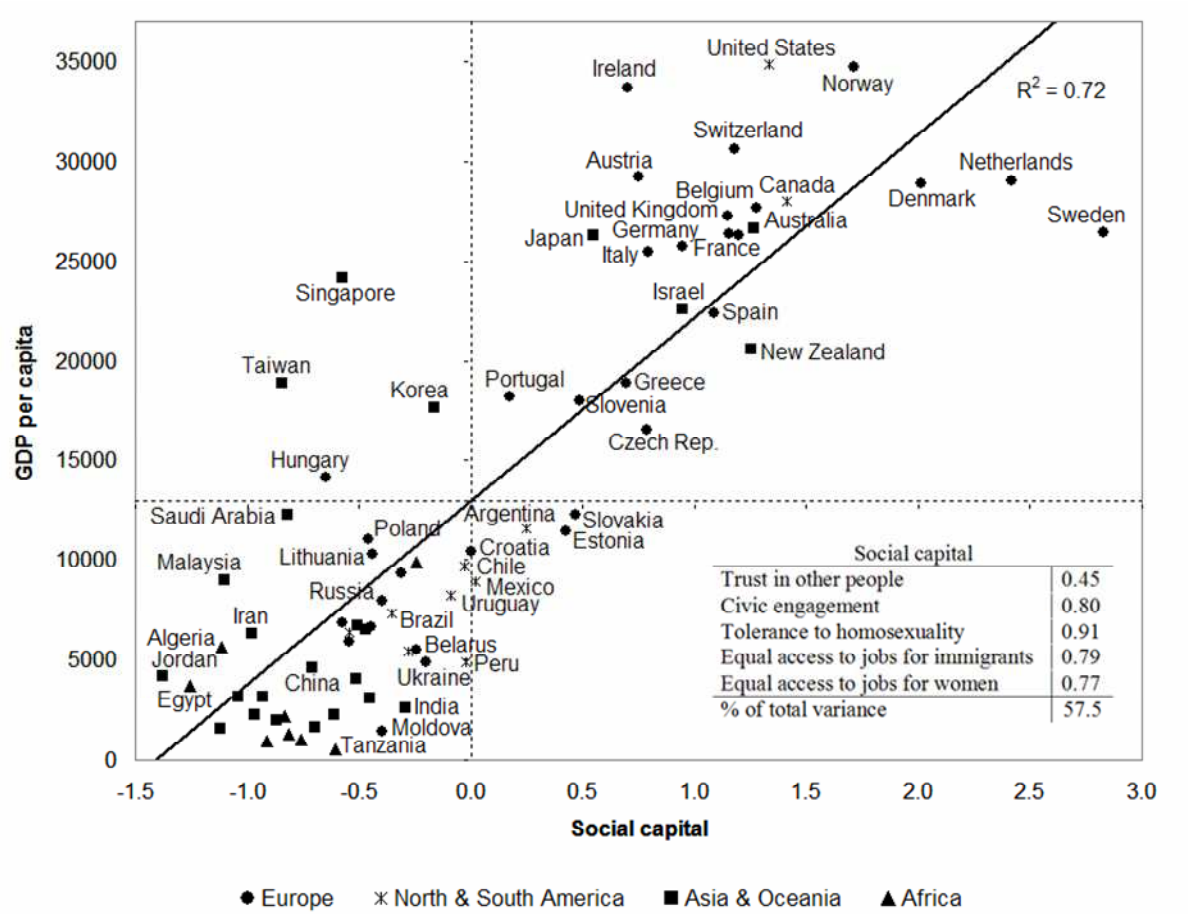
Third, the lowest correlation with GDP per capita is found for the financial system variable (Figure 3), and among the deviants one finds some developing countries, especially South Africa and Malaysia, with much more sophisticated financial systems than one should expect from their overall levels of development (while it is the other way around for some developed nations, Norway and Ireland in particular). It would of course have been preferable to be able to include data on finance of start ups, venture capital etc. but unfortunately such data were not available for a sufficiently large number of countries.

Figure 4. GDP per capita and business regulation over 2000-2004



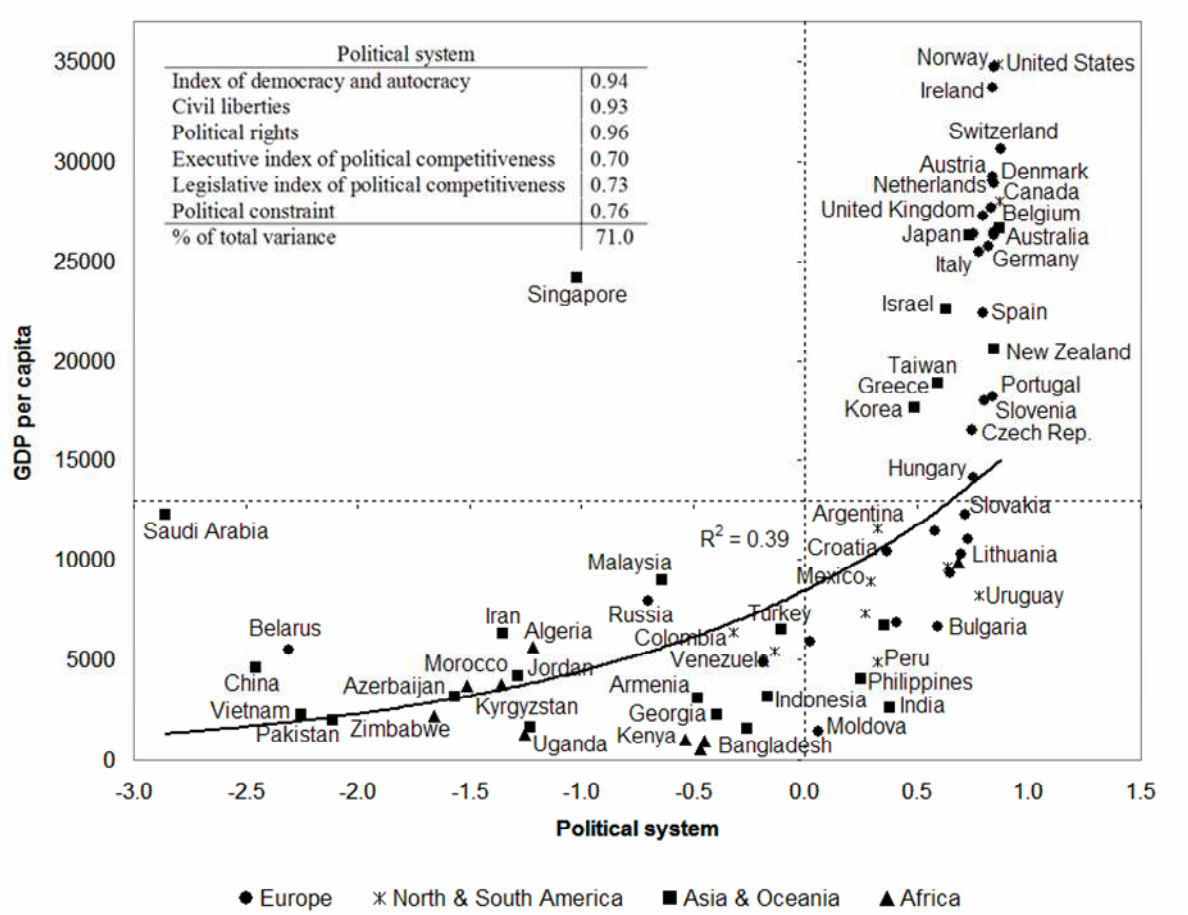
Fourth, the countries with the highest recorded values for "business regulation" and "social capital" are not the usual suspects, such as the United States, Japan and perhaps Germany, but a group of small, high-income countries from Northern Europe (Figures 4 and 5). This finding clearly begs further questions about the role of deeper social and political factors in the long-run development of these countries. Finally, there is a group of (overwhelmingly Muslim) countries in Africa and Asia that score very low on social capital (or cohesion), mainly due to widespread negative attitudes towards inclusion of women, homosexuals and immigrants into society on equal terms (Figure 5). An interesting question is how persistent these attitudes are and to what extent it will prevent these countries from exploiting the development potential facing them.

Figure 5. GDP per capita and social capital over 2000-2004



For the purpose of comparison we also made an attempt to take into account the view, often attributed to the World Bank and Western governments, that what really matters for development is adoption of a Western-type political system (or democracy in other words) and openness to trade, FDI and licensing (Figures 6 and 7). As for the Political System, the index is a measure of the degree of "westernization" of the political institutions of a given country, the evidence of a correlation with GDP was found to be modest. In fact most countries cluster to the right in the figure ("democratic" system) independent of the level of development.

Figure 6. GDP per capita and political system over 2000-2004



Although it is widespread view that openness to trade is important for growth, the evidence supporting this conclusion is in fact quite weak (Rodrik and Rodriguez 1999, Rodrik et al. 2004, Fagerberg and Srholec 2006). Our openness index reflects openness to imports, inward FDI and royalty and license payments abroad. We experimented with different ways to define openness, such adjusting for country size, but in no case was it possible to find evidence of a significant correlation with GDP per capita. In fact, it appears to be a fairly robust result that the degree of openness to international transactions does not discriminate between countries that manage to escape the low development trap and those that continue to be poor. This should, of course, not be interpreted in support in "closedness" or anything of the sort. Arguably, this is an area in need of further research.

Figure 7. GDP per capita and openness (orthogonal to size) over 2000-2004

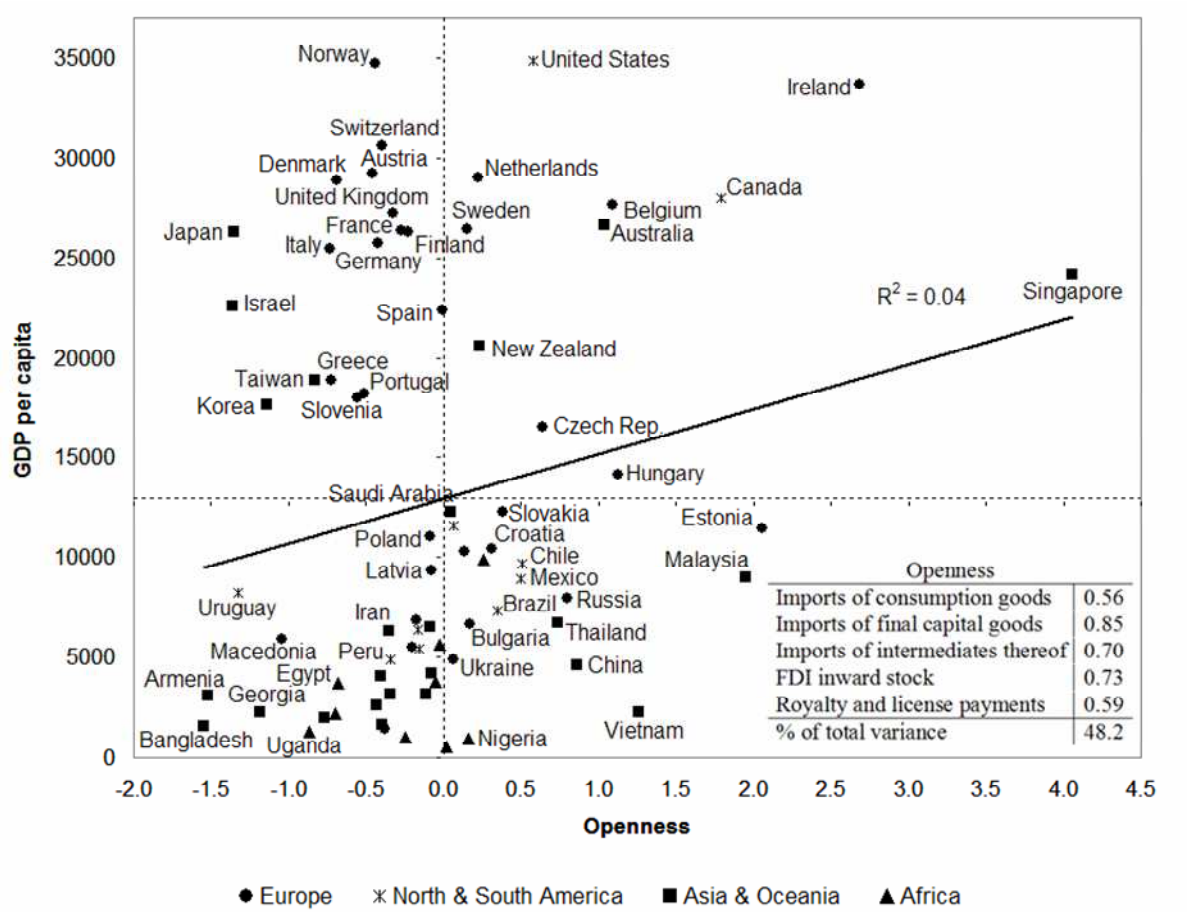


Table 1 confirms that most aspects of development tend to be correlated, even though the degree of correlation differs. We may tentatively use these differences to make some general comments on the role of different factors in development. For instance, the results suggest that there is a strong correlation between technological capability, business regulation and social capital, confirming, we would suggest, the important role played by deeper social and cultural factors for innovation and development. This contrasts with the role played by openness, which hardly correlates with anything. Thus the results suggest that the openness that matters most for development is openness to people who are different from yourself, e.g., the kind of factors included in our "social capital" measure. Moreover, the results indicate that "innovation-friendly" business regulation (or governance) is much more important than, say, the type of political system.

Table 1. Correlation table

	Technological capability	Education system	Financial system	Business regulation	Social capital	Political system	Openness (orthogonal to size)	Number of observations
Technological capability	1.00							65
Education system	0.75	1.00						75
Financial system	0.75	0.43	1.00					75
Business regulation	0.93	0.66	0.80	1.00				75
Social capital	0.85	0.72	0.58	0.79	1.00			75
Political system	0.58	0.59	0.38	0.53	0.62	1.00		75
Openness (orthogonal to size)	0.10	0.12	0.23	0.23	0.04	-0.08	1.00	75

4. Innovation, development and policy

Is innovation important for development? And if so, how? The answers to these questions depend, we will argue, on what you mean by the term innovation. One popular perception of innovation, that you meet in media every day, is that has to do with developing brand new, advanced solutions for sophisticated, well-off customers, through exploitation of the most recent advances in knowledge. Such innovation is normally seen as carried out by highly educated labour in R&D intensive companies, being large or small, with strong ties to leading centers of excellence in the scientific world. Hence innovation in the above sense is a typical "first class" activity. Those at the "third class", the developing countries, are only indirectly affected.

This stylized story is not without some truth. We know that R&D is very concentrated, and that the tendency towards internationalization of production is not followed by a similar internationalization of R&D. In fact, most internationalized firms continue to do the lion's share of their R&D at home and to the extent that other locations are considered these are normally close to "centers of excellence" and not in the developing part of the world (Narula 2003), except perhaps for China recently (UNCTAD 2005). Thus spread of production does not automatically imply spread of knowledge and the implicit economic benefits thereof. Researchers who have tried to find evidence of such benefits from foreign direct investment have had a hard time (and sometimes had to conclude to the contrary, see Görg and

Greenaway 2002). So if this is what innovation is about, one might be tempted to conclude that it is not of much help for the developing part of the world?

There is, however, another way to look at innovation that goes significantly beyond the high tech phobia just described. In this, broader perspective, innovation – the attempt to try out new or improved products, processes or ways to do things – is an aspect of most if not all economic activities (Kline and Rosenberg 1986, Bell and Pavitt 1993). Although many of the outcomes are less glamorous than celebrated breakthroughs in the high-tech world, there is no reason to believe that their cumulative social and economic impact is smaller (Fagerberg, et al. 2004). Hence, even in so-called low-tech activities, there may be a lot of innovation going on, and the economic effects may be very large (von Tunzelmann and Acha 2004). Arguably, in this broader perspective, innovation becomes as important for developing countries as for the rich part of the world, an argument which is also strongly supported by evidence from the surveys of innovation activities in firms referred to above.

This shift of perspective has some important implications for discussions of policy. Innovation policy, especially in technologically and economically not very advanced environments, needs to have a broad focus (UNCTAD 2007). The question should not be how to attract so-called high tech activities from abroad but how to unleash the creative potential of actors (firms, organizations, people) that are already there, in a broad range of sectors and activities. This naturally leads to a focus on the quality of the environment in which the various economic actors operate. A number of questions arise. How knowledgeable is the environment? How easy is it for a potential innovator to mobilize the necessary skills, assets and external sources of knowledge that will be required when moving from the idea to the innovation stage? And how innovation-friendly is the system of governance and the social environment more generally?

An important lesson is that it is necessary to consider the joint impact of all these factors, because the (causal) chain is never stronger than its weakest link. Although the nature of the data does not allow for proofs of causality, the strong interdependence between technological capabilities, innovation-friendly governance and deeper social and cultural factors that we have been able to confirm here, goes a long way towards suggesting that such interdependencies are indeed crucial for development. This is also an important reason why a systemic approach to the development and evaluation of policy is required.

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Appendix (data & sources)

A brief overview of definitions, sources and time/country coverage of the indicators is given in the table below. The main source of data is the World Bank (World Development Indicators 2007), which combines various sources of data for a large sample of countries. The database has been complemented by data from other organizations such as UNESCO, UNCTAD, the UN Comtrade Database, the World Value Survey and others, and in addition surveys and datasets produced by research projects. National sources were only used for Singapore and Taiwan if necessary.

Sample size and composition was given by availability of data from the World Value Survey. We use the data in the form of five-year averages over 2000-2004 to limit influence of shocks and measurement errors occurring in specific years, expect the data from the World Value Survey that refers to the latest period available. Although the selected indicators have broad coverage, in some cases there were missing values that had to be dealt with. A number of the advanced countries do not monitor literacy anymore. Following UNDP (2006), we assumed that all of these countries maintain 99% literacy. The remaining missing data were estimated using the *impute* procedure in Stata 9.2 (see the Stata 9 Manual for details). We based the estimation on data for the other indicators with full coverage in the dataset. The number of observations estimated by the procedure is given in the last column of the following table.

Indicator & definition	*Scaling*	*Source*	*Average over period*	*Countries estimated*
Gross Domestic Product (GDP): GDP converted to (constant 2000) international USD using purchasing power parity rates (PPP).	per capita	World Bank (World Development Indicators 2007)	2000-2004	0
Scientific articles: Counts of articles published in journals covered by Science Citation Index (SCI) and Social Sciences Citation Index (SSCI).	per capita	U.S. National Science Foundation (Science and Engineering Indicators 2006)	2000-2003	0
PCT patent applications: Applications for patens under the Patent Cooperation Treaty (PCT) classified by country of residence of the first named applicant.	per capita	WIPO	2000-2004	0
Research and development (R&D): Intramural expenditure on research and experimental development performed on the national territory.	% of GDP	World Bank (World Development Indicators 2007), OECD (MSTI Database), UNESCO (S&T Statistics), RICYT and national sources	2000-2004	3
Doctoral enrolment: Students of all ages (gross) in tertiary programmes which are devoted to original research and lead to the award of an advanced research qualification (ISCED97 code 6) expressed as a percentage of the tertiary school-age population.	% gross	UNESCO (Global Education Digest, September 2006 release)	2000-2004	6
S&E enrolment: Students of all ages (gross) in science, engineering, manufacturing and construction tertiary programmes expressed as a percentage of the tertiary school-age population.	% gross	UNESCO (Global Education Digest, September 2006 release)	2000-2004	9
Professionals: Share of professionals, technicians and associate professionals (ISCO88 codes 2 and 3) in total employment.	per employee	ILO LABORSTA Database 2006	2000-2004	8
Trademarks: Applications of a resident for registration of a trademark with a national or regional trademark office. Trademarks are distinctive signs that identify goods or services as those produced or provided by a specific person or enterprise.	per capita	World Bank (World Development Indicators 2007)	2000-2004	9
ISO 9000 certifications: A family of standards approved by the International Standards Organization (ISO) that define a quality management and assurance program.	per capita	International Organization for Standardization (The ISO Surveys of ISO 9000 Certificates)	2000-2003	
Personal computers: Computers designed to be used by a single individual.	per capita	World Bank (World Development Indicators 2007)	2000-2004	1
Internet users: Internet users are people with access to the worldwide network.	per capita	World Bank (World Development Indicators 2007)	2000-2004	0
Fixed line and mobile phone subscribers: Telephone mainlines and users of portable telephones with access to the the public switched telephone network (PSTN).	per capita	World Bank (World Development Indicators 2007)	2000-2004	0
Literacy: Adult literacy rate is the percentage of people ages 15 and above who can read , understand a write a short, simple statement on their everyday life.	%	UNESCO (Global Education Digest, September 2006 release), UNDP (2006)	2000-2004	0
Secondary school enrolment: Number of secondary students of all ages (gross) expressed as a percentage of the secondary school-age population.	% gross	UNESCO (Global Education Digest, September 2006 release)	2000-2004	1
Tertiary school enrolment: Number of tertiary students of all ages (gross) expressed as a percentage of the tertiary school-age population.	% gross	UNESCO (Global Education Digest, September 2006 release)	2000-2004	0

Domestic credit to private sector: Financial resources provided to the private sector, such as through loans, purchases of non-equity securities, trade credits and other accounts receivable, that establish a claim for repayment.	% of GDP	World Bank (World Development Indicators 2007)	2000-2004	0
Market capitalization of listed companies: The share price times the number of shares outstanding (also known as market value) of domestically incorporated companies listed on the country's stock exchanges at the end of the year.	% of GDP	World Bank (World Development Indicators 2007)	2000-2004	3
Interest rate spread: The interest rate charged by banks on loans to prime customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits.	logs	World Bank (World Development Indicators 2007)	2000-2004	0
Bank nonperforming loans: The value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions).	%	World Bank (World Development Indicators 2007)	2000-2004	8
Time to start a business: The number of calendar days needed to complete the procedures to legally operate a business.	days	World Bank (Doing Business Database 2007)	2003-2004	0
Time to close a business: The number of calendar days required to complete a bankruptcy.	days	World Bank (Doing Business Database 2007)	2003-2004	0
Protection of intellectual property: Adherence to protection of intellectual property rights.	index (0 to 10)	Gwartney and Lawson (2005); based on World Economic Forum (Global Competitiveness Report, various issues)	2000-2003	7
Law and order: The degree to which the citizens of a country accept the authority of established institutions in making and implementing laws and regulating disputes.	index (0 to 10)	PRS Group (International Country Risk Guide, various issues)	2000-2004	3
Corruption: The Corruption Perception Index reflects the perceptions of well-informed people with regard to the extent of corruption, defined as the misuse of public power for private benefit.	index (0 to 10)	Transparency International (Corruption Perceptions Index, various editions)	2000-2004	0
Women's rights: A combined score on adherence to women's economic, political and social rights.	index (0 to 9)	Cingranelli and Richards (2004)	2000-2004	0
Index of democracy and autocracy: In institutionalized autocracies chief executives are appointed by the political elite and exercise power with few constraints, while in institutionalized democracies executives are elected and constraints substantial. The rank goes from autocracy to democracy in increasing order (POLITY2 variable)	index (-10 to 10)	Marshall and Jaggers (2003) - Polity IV Dataset	2000-2003	0
Political constraint: The variable measures the probability that a change in actor preferences may change governmental policy. It is based on the number of independent branches of government (with veto power) modified by the extent of alignment across branches of government (POLCONIII variable)	index (0 to 1)	Henisz (2000, 2005)	2000-2004	0
Executive index of political competitiveness (EIEC): The variable reflects competitiveness for posts in executive branches in government. It reflects the balance of	index (1 to 7)	Beck, et al. (2001, 2005)	2000-2004	0

power between legislature & executive, if the political system is presidential vs. parliamentary, whether the military has significant influence, , etc.				
Legislative index of political competitiveness (LIEC): The highest score of the index goes to countries elections in which multiple parties compete in elections and the largest party receives less than 75% of the vote. The lowest score goes to countries with and unelected legislature. Voting irregularities, election boycotts etc. are also taken into account.	index (1 to 7)	Beck, et al. (2001, 2005)	2000-2004	0
Trust in other people: Answer of the question: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?"	%	World Value Survey	the latest year available until 2003	3
Tolerance to homosexuality: Average answer on a question whether homosexuality can always vs. never (ten point scale) be justified.	index (0 to 100)	World Value Survey		5
Civic engagement: Average answer to a question of whether the respondent has signed, might sign or would never sign under any circumstances (three point scale) a petition.	index (0 to 100)	World Value Survey		6
Equal access to jobs for immigrants: Average answer on question whether the respondent agrees or disagrees (three point scale) with the statement that when jobs are scarce, employers should give priority to local people over immigrants.	index (0 to 100)	World Value Survey		5
Equal access to jobs for women: Average answer on question whether the respondent agrees or disagrees (three point scale) with the statement that when jobs are scarce, men should have more right to a job than women.	index (0 to 100)	World Value Survey		4
Imports of consumption goods: Imports of durable, semi-durable and non-durable consumption goods not elsewhere specified (BEC, rev. 3 codes 61, 62 and 63).	% of GDP	UN Comtrade Database 2007	2000-2004	1
Imports of final capital goods: Imports of final capital goods including transport equipment (BEC, rev. 3 codes 41, 51 and 52).	% of GDP	UN Comtrade Database 2007	2000-2004	1
Imports of intermediates thereof: Imports of parts and accessories of capital goods including transport equipment (BEC, rev. 3 codes 42 and 53).	% of GDP	UN Comtrade Database 2007	2000-2004	1
Foreign direct investment (FDI) inward stock: A received investment that involves a long-term relationship and reflects a lasting interest in and control by a resident entity in one economy of an enterprise resident in a different economy.	% of GDP	UNCTAD (FDI Database 2006)	2000-2003	0
Royalty and license payments: Payments between residents and non-residents for the authorized use of intangible assets and proprietary rights (such as patents etc.) and for the use, through licensing, of produced originals of prototypes (such as films and manuscripts).	% of GDP	World Bank (World Development Indicators 2007)	2000-2004	8

[1] Kim's definition of technological capability is quite similar to the notion of "absorptive capacity" (Cohen and Levinthal 1990), andin later works he actually used the two terms interchangeably.

[2] Some researchers in this area emphasise a need for developing a common methodology, based on the functions and activities of the system, to guide empirical work (Liu and White 2001, Johnson and Jacobsson 2003 and Edquist 2004), while others advocate the advantage of keeping the approach open and flexible (Lundvall 2003).

[3] For classical texts on the subject see Bourdieu (1985) and Coleman (1990). In sociology the term is often used as an attribute of individuals, not as a characteristic of communities, as in the tradition from Putnam (1993). For an overview and discussion of different usages of the term see Portes (1998).

[4] Note that Temple (1998) tends to use the terms "social capability", "social capital" and "social arrangements" interchangeably.

[5] How many factors to retain is an important question when using this technique. A common assumption is that for a factor to be retained, it should explain at least as much of the total variance as an average indicator; e.g., the factor should have "eigenvalue" above one. In the estimates presented here only one factor with an eigenvalue above one was identified and therefore retained.

[6] Since some of the indicators, such as R&D expenditure, S&E tertiary enrolment and employment of professionals and technicians, are not available for all countries, we had to limit our analysis of technological capabilities to a sample of 65 countries with the best coverage (as compared to 75 countries for the other indicators further below).

[7] Ireland is a major outlier, however, since more than 20% of its national income tends to be repatriated to investors abroad, in terms of GNI per capita it would not be that far from the regression line.

[8] For example, there are differences in sampling, response rate, reference period and formulation of the questions about innovation that limit the possibility for broad cross-country comparisons. Some of the results obtained from these add to these concerns. In the CIS-type surveys carried out in developing countries the share of manufacturing firms that claim to innovate range from around 50% in South Africa to less than 10% in Thailand. In the PICS survey the differences are even larger, from more than 80% in Brazil to less than 20% in Egypt. The question that suggests itself is to what extent these differences should be considered as real or just an artefact of the data? This is an important and timely issue, but we are currently not aware of research that throws much light on this. See, however, the discussion in Srholec (2008).

[9] For rich countries, in contrast, the relationship is almost vertical. Thus, there is a strong tendency towards convergence in educational standards as countries get richer, indicating, arguably, that without adequate investments in skills countries get nowhere. However, this observed tendency towards convergence may also reflect that there are upper bounds to the indicators used in the construction of the index.